United States General Accounting Office

GAO

Report to Congressional Committees

June 2002

AIR POLLUTION

Emissions from Older Electricity Generating Units

GAO-02-709

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
00JUN2002	N/A	-

Title and Subtitle AIR POLLUTION: Emissions from Older Electricity Generating Units	**Contract Number**
	Grant Number
	Program Element Number
Author(s)	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) U.S. General Accounting Office 441 G Street NW, Room LM Washington, D.C. 20548	**Performing Organization Report Number** GAO-02-709
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)

Distribution/Availability Statement
Approved for public release, distribution unlimited

Supplementary Notes

Abstract
see report

Subject Terms

Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** SAR

Number of Pages
25

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GAO
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, DC 20548

June 12, 2002

The Honorable James M. Jeffords
Chairman, Committee on Environment
and Public Works
United States Senate

The Honorable Joseph I. Lieberman
Chairman, Subcommittee on Clean Air,
Wetlands, and Climate Change
Committee on Environment and Public Works
United States Senate

Electricity is critical to the nation's economy and standard of living. The nation depends on a variety of fuels to generate this electricity, including coal, natural gas, nuclear power, oil, and renewable sources. While fossil fuels—coal, natural gas, and oil—account for more than two thirds of our electricity, generating units that burn these fuels are major sources of airborne emissions that pose human health and environmental risks. Two of the substances emitted, sulfur dioxide and nitrogen oxides, have been linked to respiratory illness and acid rain. A third, carbon dioxide, has been linked to global climate change and its potential adverse effects, including drought and severe weather conditions. Addressing these concerns without compromising economic and energy goals continues to pose significant challenges.

To help limit emissions and protect air quality, the Environmental Protection Agency (EPA), under the Clean Air Act, regulates emissions of sulfur dioxide and nitrogen oxides from a variety of sources including electricity generating units that burn fossil fuels, other industrial sources, and automobiles. EPA does not regulate carbon dioxide. Under the Clean Air Act, EPA requires certain electricity generating units built or modified after August 17, 1971, to meet uniform national emissions standards for the regulated substances.[1] Units built before that date that have not undergone modifications do not have to meet these standards. In passing the act, the Congress directed EPA to establish standards for units built or

[1]The standards are called New Source Performance Standards and establish the maximum allowable emissions from new sources and existing sources that undergo modifications. For simplicity, we refer to them as "new source standards."

modified after that date, on the basis of evidence that adding pollution controls at the time of construction was more efficient than adding them to all existing units.

Many of the older units still operate—1,396 (57 percent) of the fossil-fuel units that generated electricity in 2000 began operating before 1972.[2] (We refer to fossil-fuel generating units that began operation before 1972 as "older units" and those that began operating in 1972 or later as "newer units.") Provided they otherwise comply with the act, these older units may legally emit sulfur dioxide and nitrogen oxides at higher rates than newer units that are subject to new source standards. Thus, one way of describing the air quality impact of the older units is to estimate their "additional" emissions—that is, the difference between their actual emissions during a given period and the maximum emissions allowed under the new source standards.

In May 2001, the administration issued a *National Energy Policy* report, which cited forecast needs by the Energy Information Administration for additional power plants over the next 20 years. In your September 2001 letter, you asked us to provide information on, among other things, air emissions from future electricity generation. As part of this work, which we will present in a subsequent report, we obtained information and briefed your offices on emissions in 2000 (the most current data available) from existing units that burned fossil fuel. This report transmits that information. Specifically, we determined

- the proportions of sulfur dioxide, nitrogen oxides, and carbon dioxide emitted and electricity generated by older fossil-fuel units (as a group) relative to newer units (as a group) in 2000, as well as the locations and type of fuel burned by units responsible for the majority of the emissions; and
- the proportions of older fossil-fuel units that, in 2000, emitted sulfur dioxide and nitrogen oxides at rates above the new source standards applicable to newer units, the location of these additional emissions, and the type of fuel burned by these units.

To address these objectives we analyzed data on air emissions and electricity generation from units with a generating capacity greater than

[2]We used 1972 as the cutoff date for our analysis—instead of August 17, 1971—because data on the age of generating units were only available for full years.

15 megawatts.[3] We obtained these data from Platts/RDI, a private vendor that integrates data on air emissions from EPA with data on electricity generation and the age of individual units from the Energy Information Administration. While these data were the most comprehensive available, they may understate the total emissions from fossil-fuel units because some units are not required to report their emissions to regulatory agencies. The units that did not report emissions, however, generated less than 1 percent of the electricity from older units in 2000. Of the 1,396 operating older units, 1,157 (83 percent) reported emissions data in 2000.

Results in Brief

Older electricity generating units—those that began operating before 1972—emitted 59 percent of the sulfur dioxide, 47 percent of the nitrogen oxides, and 42 percent of the carbon dioxide from fossil-fuel units in 2000, while generating 42 percent of all electricity produced by fossil-fuel units. Units that began operating in or after 1972 were responsible for the remainder of the emissions and electricity production. For equal quantities of electricity generated, older units, in the aggregate, emitted about twice as much sulfur dioxide and about 25 percent more nitrogen oxides than did the newer units which must meet the new source standards for these substances. Older and newer units emitted about the same amount of carbon dioxide for equal quantities of electricity generated. Of the older units, those in the Mid-Atlantic, Midwest, and Southeast produced the majority of the emissions, and in disproportionate quantities for the amount of electricity they generated compared with units located in other parts of the country. Older units that burned coal released a disproportionate share of emissions for the electricity they produced compared with units burning natural gas and oil.

In 2000, 36 percent of older units emitted sulfur dioxide at levels above the new source standards applicable to newer units, and 73 percent emitted nitrogen oxides at levels above the standards. These "additional" emissions—those above the standards for newer units—accounted for 34 percent of the sulfur dioxide and 60 percent of the nitrogen oxides produced by older units. Most of the additional emissions were released from units located in the Mid-Atlantic, Midwestern, and Southeastern United States. Coal-burning units emitted 99 percent of the additional sulfur dioxide and 91 percent of the additional nitrogen oxides, while other fossil fuel-burning units accounted for the remainder.

[3]A megawatt is one million watts, or enough electricity to power about 750 homes.

Background

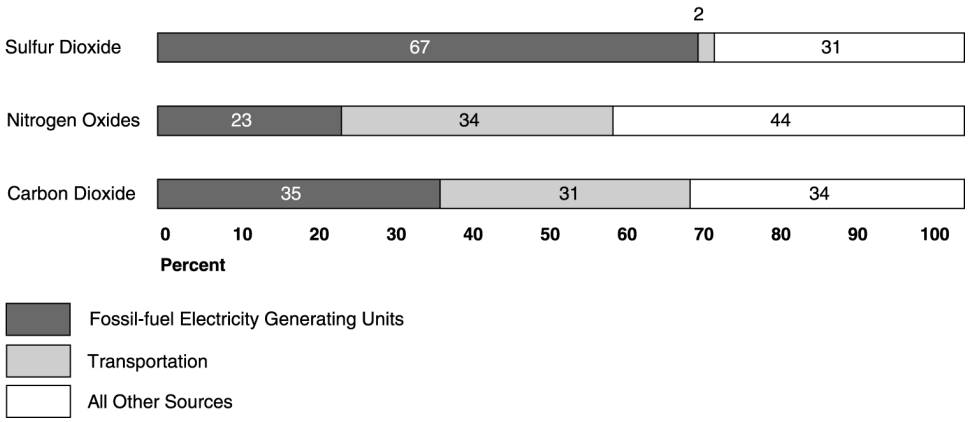
Sulfur dioxide and nitrogen oxides have been linked to a variety of health and environmental concerns, and carbon dioxide has been linked to global warming. For example, sulfur dioxide and nitrogen oxides contribute to the formation of fine particles,[4] and nitrogen oxides contribute to the formation of ozone.[5] Both fine particles and ozone have been linked to respiratory illnesses. For example, fine particles have been linked to premature death, aggravated asthma, and chronic bronchitis, while ozone can inflame lung tissue and increase susceptibility to bronchitis and pneumonia. In addition to affecting health, sulfur dioxide and nitrogen oxides reduce visibility and contribute to acid rain, which harms aquatic life and degrades forests. Carbon dioxide has been linked to increases in air and ocean temperatures. Such climate changes, by the end of the century, could cause rising sea levels, droughts, and wind and flood damage, according to the National Academy of Sciences.

Electricity generating units that burn fossil fuels, along with other stationary sources (such as chemical manufacturers and petroleum refineries), and transportation sources (such as cars) emit one or all of these substances. Figure 1 compares emissions of sulfur dioxide, nitrogen oxides, and carbon dioxide from fossil-fuel units to those from other sources in 1999, the most recent year for which data for all three substances were available. While the overall proportion of each substance emitted by fossil-fuel units varied—from 67 percent of all sulfur dioxide to 23 percent of all nitrogen oxides—these units emitted more of each substance than any other industrial source in 1999.

[4]Sulfur dioxide and nitrogen oxides can transform into fine particles in the atmosphere. Fine particles are a subset of particulate matter, a regulated pollutant.

[5]Ozone, a regulated pollutant, forms when nitrogen oxides react with volatile organic compounds in the presence of heat and sunlight.

Figure 1: Percentage of Total U.S. Emissions Released by Fossil-Fuel Generating Units, the Transportation Sector, and Other Sources in 1999



Note: Transportation data for nitrogen oxides and sulfur dioxide include only highway vehicles. Data for carbon dioxide include other transportation sources, such as aircraft and boats. Percentages for nitrogen oxides do not total 100 due to rounding.

Source: EPA.

Under the Clean Air Act, EPA establishes air quality standards and regulates emissions from a number of sources, including electricity generating units that burn fossil fuels. The act required EPA to issue regulations establishing federal performance standards for new sources of air pollution within certain categories of stationary sources. Accordingly, EPA issued new source standards for certain generating units with a capacity greater than 73 megawatts that were built or modified after August 17, 1971. Over time, EPA has made the standards more stringent, subjecting other types of units and those with a lower generating capacity to the standards. The standards do not apply to older units built before that date that have not been modified, although some older units do meet the standards. In addition, under a program called New Source Review, older units must install modern pollution controls when they make "major modifications" that significantly increase their emissions. The level of control required depends on the air quality in the area where the unit is located—a unit in an area that does not meet federal air quality standards must install more stringent controls.[6]

[6]In recent years, the Department of Justice and/or EPA have brought nine legal actions against the owners of coal-fired power plants, alleging violations of New Source Review. As of May 2002, all nine cases were in litigation and/or settlement negotiations. EPA and the Department of Justice settled similar actions in 1999 and 2002.

Although older units are generally excluded from the new source standards, they are subject to the acid rain provisions of the Clean Air Act Amendments of 1990. The 1990 amendments directed EPA to reduce emissions of sulfur dioxide from electricity generating units by setting a limit, known as a "cap," on emissions from all units and establishing an emissions trading program. Under the trading program, each unit received emissions "allowances" that represent the right to emit one ton of sulfur dioxide. The allowances may be bought, sold, or banked for use in later years, but generating unit owners or operators must own enough allowances at the end of each year to cover their annual emissions. Although the program did not start until 1995, some units affected by the program complied earlier, according to EPA, thereby reducing sulfur dioxide emissions by about 2.2 million tons between 1990 and the end of 1994. Between 1995 and the end of 2000, the affected units reduced their sulfur dioxide emissions by 2.5 million tons (from 13.7 million tons in 1994 to 11.2 million tons in 2000)—a decline of about 18 percent. EPA expects the program to result in further reductions in sulfur dioxide emissions between 2000 and 2010.

To reduce emissions of nitrogen oxides, the acid rain provisions of the 1990 amendments limited the annual rate of emissions for individual units, rather than imposing an annual aggregate tonnage of emissions.[7] To achieve emissions reductions while minimizing the burden on generators, the legislation allowed companies with multiple units to comply with the prescribed rate by averaging their emissions rates across two or more units and ensuring that the average did not exceed the prescribed rate. Thus, individual older units may continue to emit at levels above the prescribed annual emissions rate. Although the program started in 1996, some of the affected units complied earlier, according to EPA, thereby reducing emissions of nitrogen oxides by 700,000 tons between 1990 and the end of 1995. Between 1996 and the end of 2000, the affected units reduced their emissions of nitrogen oxides by 900,000 tons (from 6.0 million tons in 1995 to 5.1 million tons in 2000)—a decline of 15 percent.

[7]The emissions rates are expressed in pounds of emissions per British thermal unit (Btu) of energy consumed as fuel by the unit.

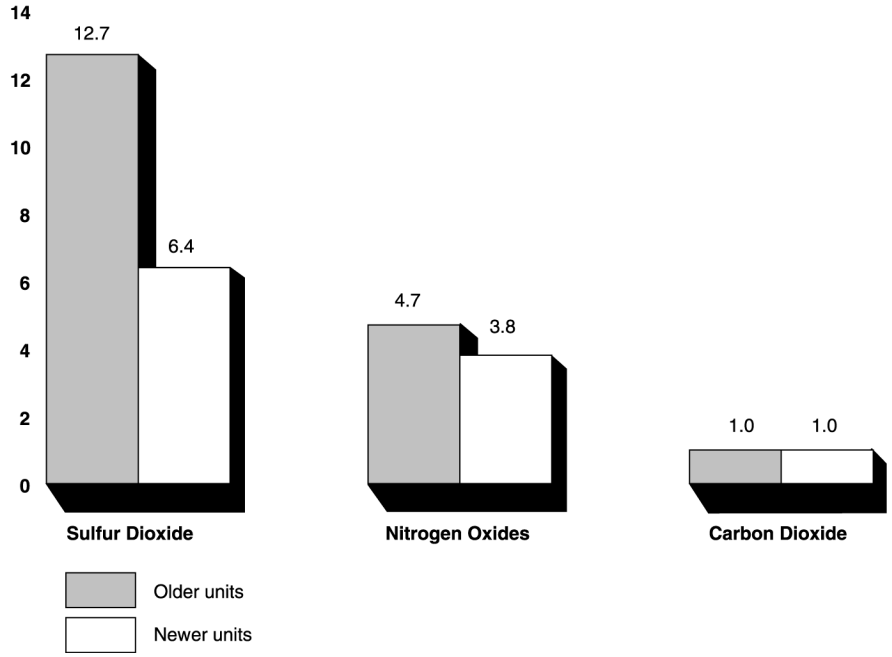
Units that Began Operation before 1972 Emitted More Sulfur Dioxide and Nitrogen Oxides per Unit of Electricity Produced than Newer Units

In 2000, older units emitted more sulfur dioxide and nitrogen oxides—and about the same amount of carbon dioxide—per unit of electricity produced than newer units. For each megawatt-hour of electricity generated, older units, in the aggregate, emitted about twice as much sulfur dioxide as newer units—12.7 pounds at older units, compared with 6.4 pounds at newer units. Older units also emitted about 25 percent more nitrogen oxides than newer units—4.7 pounds versus 3.8 pounds—for every megawatt-hour of electricity generated. Older and newer units both emitted about 1 ton of carbon dioxide for each megawatt-hour of electricity generated. (See fig. 2.) Overall, while generating 42 percent of the electricity, older units emitted 59 percent of the sulfur dioxide, 47 percent of the nitrogen oxides, and 42 percent of the carbon dioxide from fossil-fuel units.[8] Units that began operating in 1972 or after were responsible for the remainder of the emissions and electricity production.

[8]Total electricity generated by older fossil-fuel units was 1.001 billion megawatt-hours in 2000, compared with 1.398 billion megawatt hours generated by newer fossil-fuel units. Electricity generated by older units totaled about 28.6 percent of all U.S. electricity production, including production by nuclear and renewable sources.

Figure 2: Emissions per Megawatt-Hour of Electricity Generated, 2000

Sulfur dioxide and nitrogen oxides are reported in pounds; carbon dioxide is reported in tons.



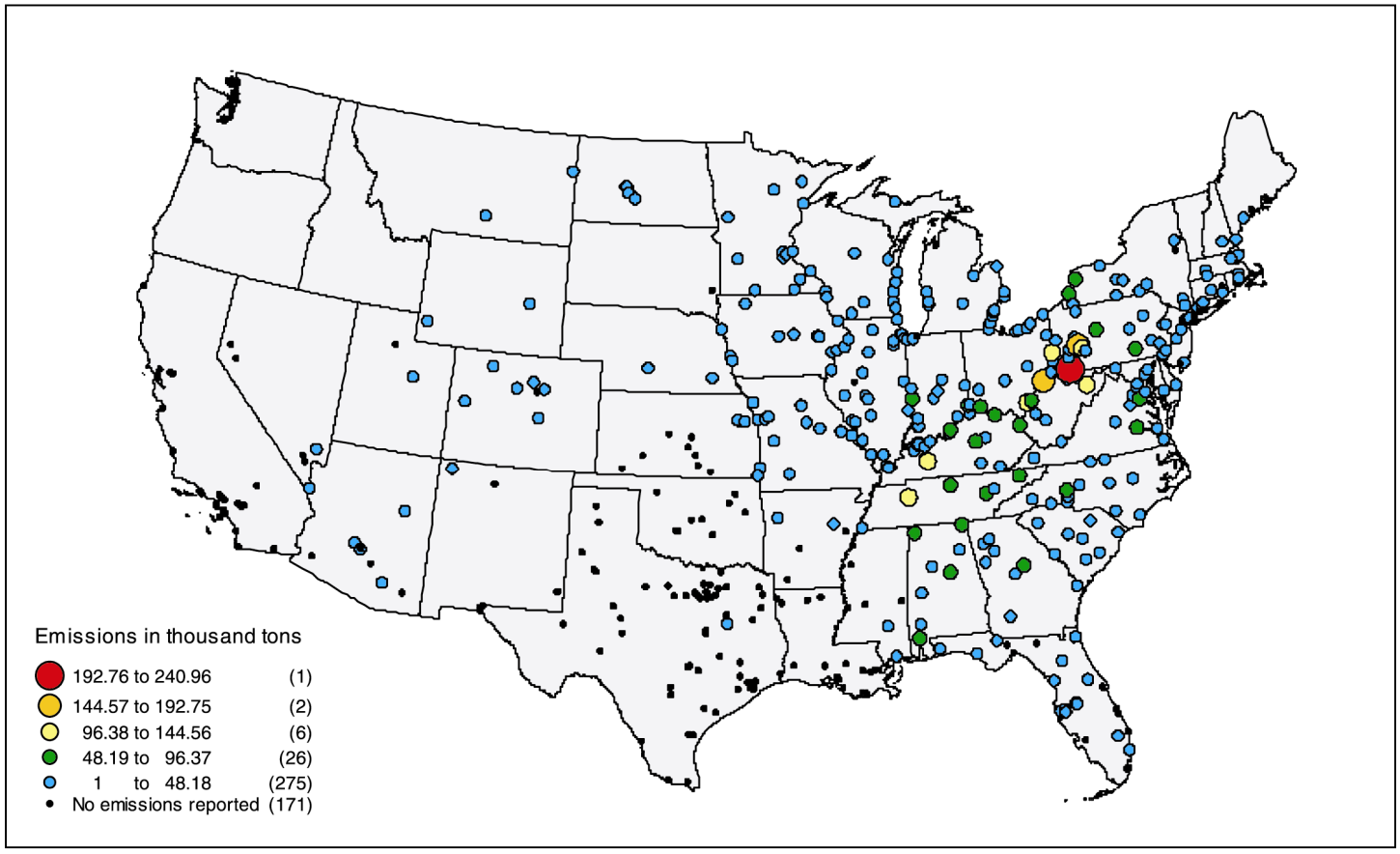
Source: GAO analysis of Platts/RDI data.

Of the older units, those in the Mid-Atlantic, Midwest, and Southeast released most of the emissions, and in disproportionate quantities for the amount of electricity they produced.[9] Specifically, older units in these regions accounted for 87 percent of the sulfur dioxide, 75 percent of the nitrogen oxides, and 70 percent of the carbon dioxide emitted from older units nationwide in 2000, while generating 67 percent of the electricity from all older units. (App. I presents, by state, data on older units' electricity generation, emissions per megawatt-hour of electricity generated, and aggregate emissions.)

Figures 3, 4, and 5 show the location of older units and the amount of sulfur dioxide, nitrogen oxides, and carbon dioxide they emitted in 2000.

[9]These regions correspond to EPA Region 3 (Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia); Region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee); and Region 5 (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin).

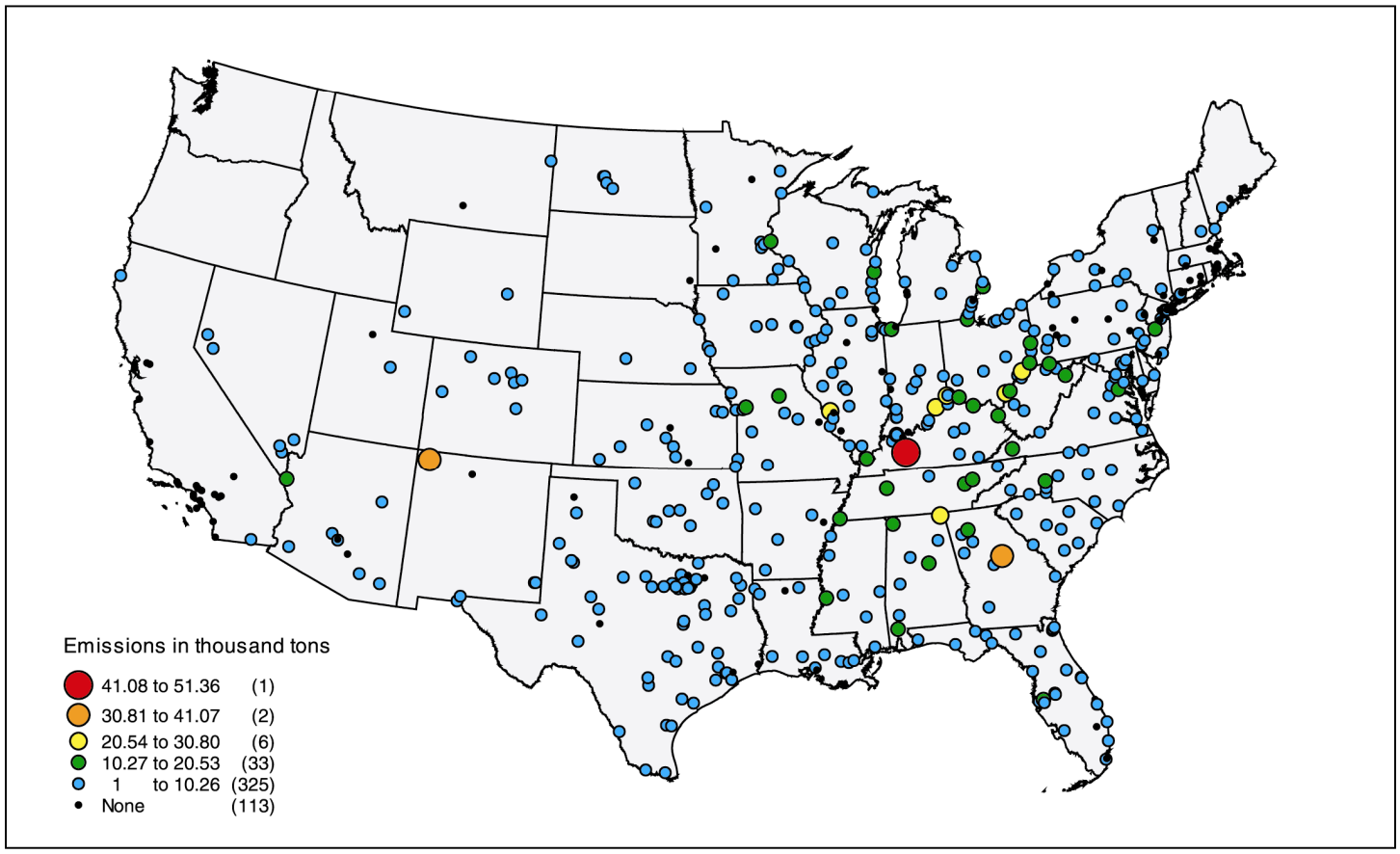
Figure 3: Sulfur Dioxide Emissions from Older Units, 2000



Source: GAO analysis of Platts/RDI data.

Note: Emissions data for units at the same location were aggregated. Emissions categories were determined by taking the level of emissions at the highest-emitting unit (or co-located units) and dividing into five equal categories. Because we aggregated emissions at co-located units, the numbers in parentheses represent the number of locations, rather than the number of individual generating units, in each category.

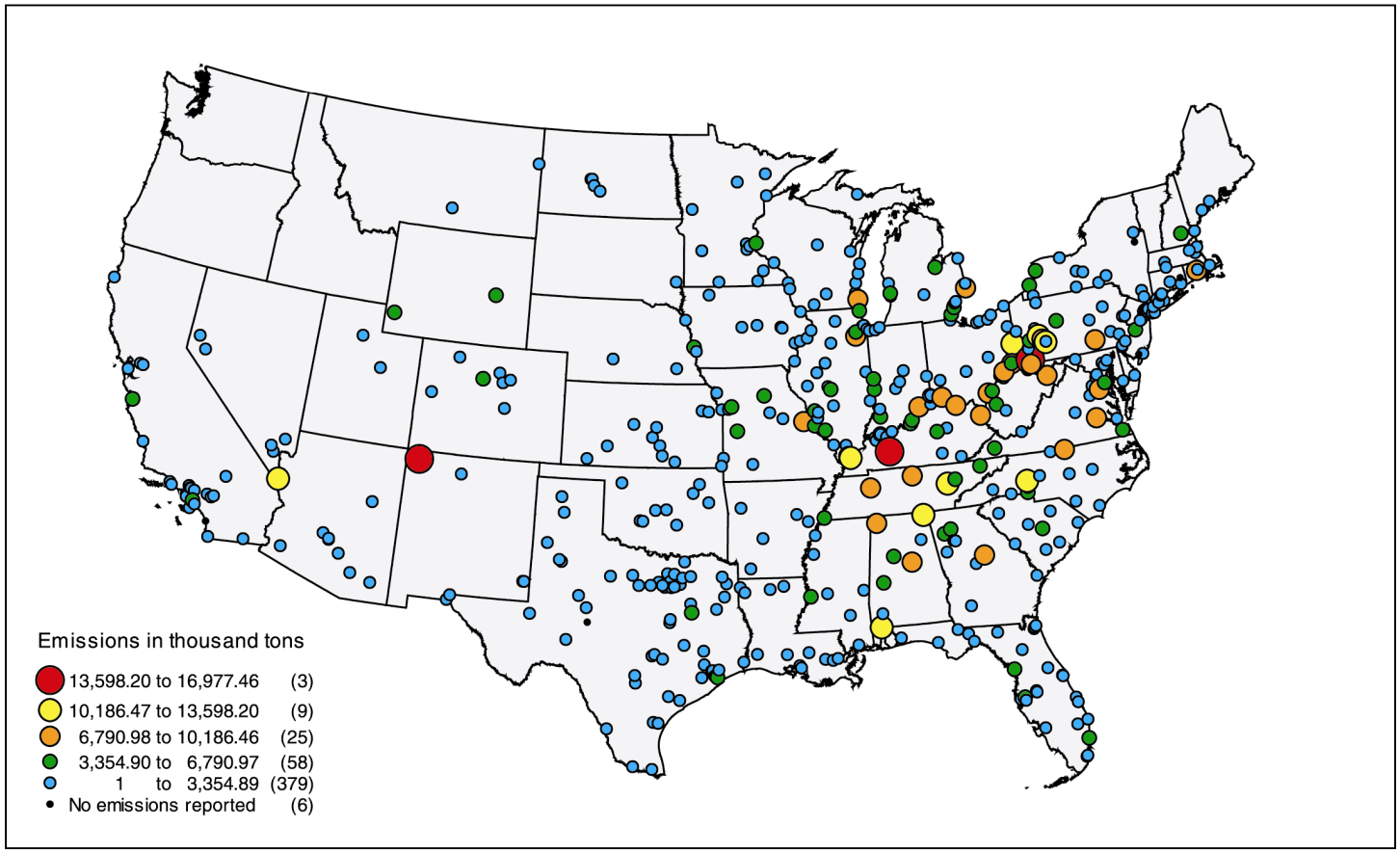
Figure 4: Nitrogen Oxides Emissions from Older Units, 2000



Source: GAO analysis of Platts/RDI data.

Note: Emissions data for units at the same location were aggregated. Emissions categories were determined by taking the level of emissions at the highest-emitting unit (or co-located units) and dividing into five equal categories. Because we aggregated emissions at co-located units, the numbers in parentheses represent the number of locations, rather than the number of individual generating units, in each category.

Figure 5: Carbon Dioxide Emissions from Older Units, 2000



Source: GAO analysis of Platts/RDI data.

Note: Emissions data for units at the same location were aggregated. Emissions categories were determined by taking the level of emissions at the highest-emitting unit (or co-located units) and dividing into five equal categories. Because we aggregated emissions at co-located units, the numbers in parentheses represent the number of locations, rather than the number of individual generating units, in each category.

Older units that burned coal released a disproportionate share of emissions for the electricity they produced, compared with units burning natural gas and oil. Coal-burning units emitted 99 percent of the sulfur dioxide, 88 percent of the nitrogen oxides, and 85 percent of the carbon dioxide from older units nationwide, while generating 79 percent of the total electricity from older units.

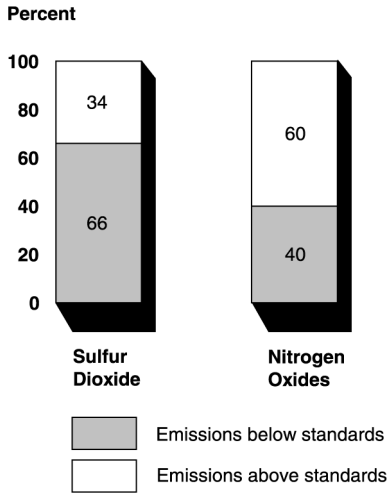
Emissions from Older Units Were Often Higher than the Emissions Standards for Newer Units

Older units generally do not have to meet the standards applicable to newer units, and in 2000, many of the older units emitted sulfur dioxide and nitrogen oxides at levels higher than what is permitted under the standards applicable to newer units for one or both of the pollutants. In that year, 36 percent of older units emitted sulfur dioxide at levels above the new source standard for that pollutant, and 73 percent emitted nitrogen oxides at levels above the new source standard. Approximately 31 percent of all older units emitted both pollutants at levels above the new source standards.[10]

As shown in figure 6, in 2000, 34 percent of the total sulfur dioxide emissions (2.13 million of 6.34 million tons) and 60 percent of the total nitrogen oxide emissions (1.41 million of 2.35 million tons) from older units were "additional" emissions—that is, emissions at levels above the standards applicable to newer units. The additional sulfur dioxide emissions represented 20 percent of the sulfur dioxide emissions from fossil-fuel units (older and newer), and the additional emissions of nitrogen oxides represented 28 percent of the emissions of nitrogen oxides from fossil-fuel units.

[10]The standards for both pollutants are expressed in pounds of pollutant per million British thermal units (Btu) of energy in the fuel, and vary depending on the age, size, and type of generating unit. The standards used for this analysis ranged from 0.5 to 1.2 pounds of sulfur dioxide per million Btu, and from 0.15 to 0.80 pounds of nitrogen oxides per million Btu. The 0.15 standard became effective in 1998.

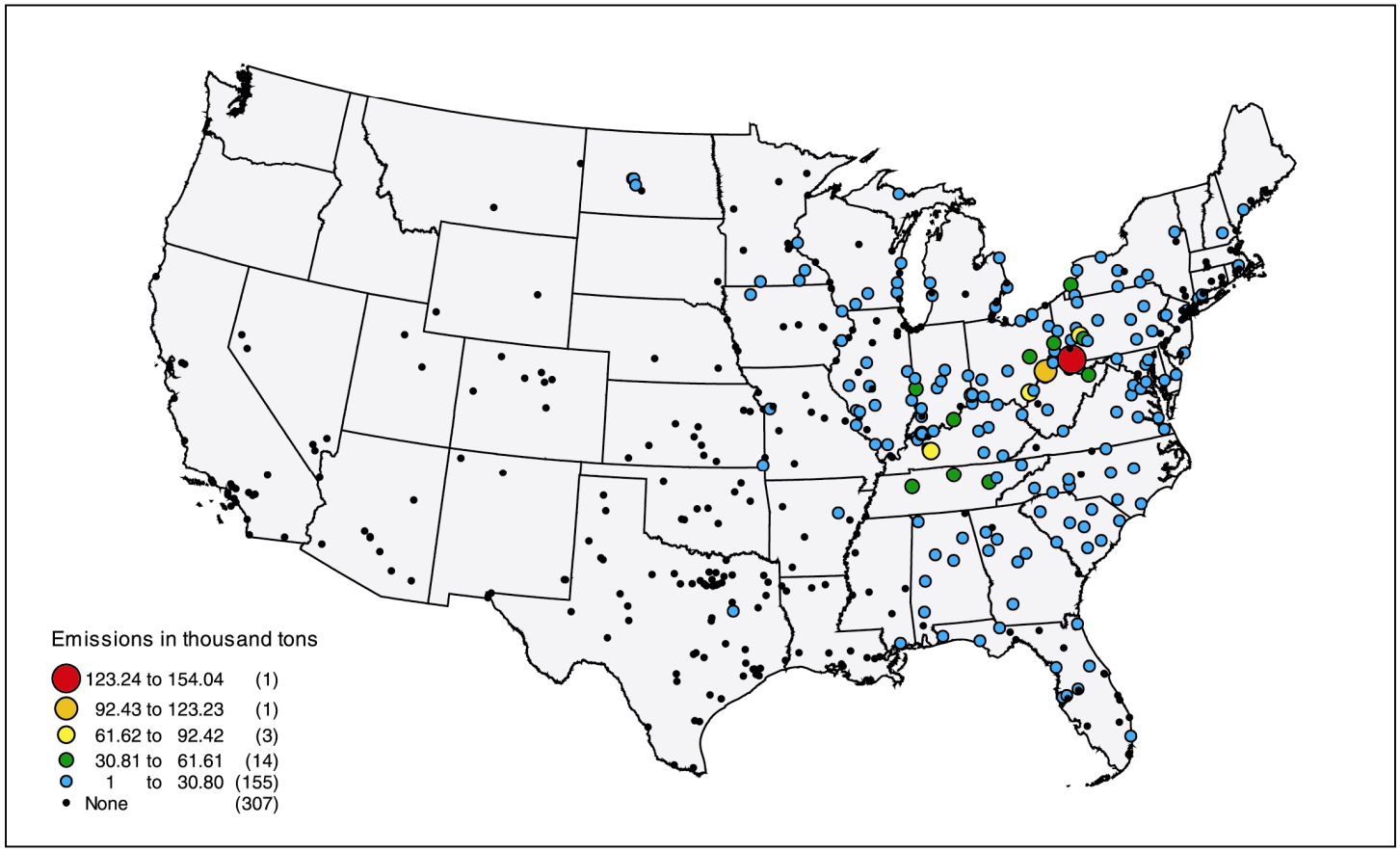
Figure 6: Proportion of Older Units' Emissions that Were Higher than New Source Standards in 2000



Source: GAO Analysis of Platts/RDI data.

Most of the additional emissions—91 percent of the sulfur dioxide and 78 percent of the nitrogen oxides—came from units located in the Mid-Atlantic, Midwest, and Southeast. Figures 7 and 8 show the level of additional emissions at older units in 2000. The majority of these emissions—99 percent of the sulfur dioxide and 91 percent of the nitrogen oxides—were from coal units, while other fossil fuel-burning units accounted for the remainder.

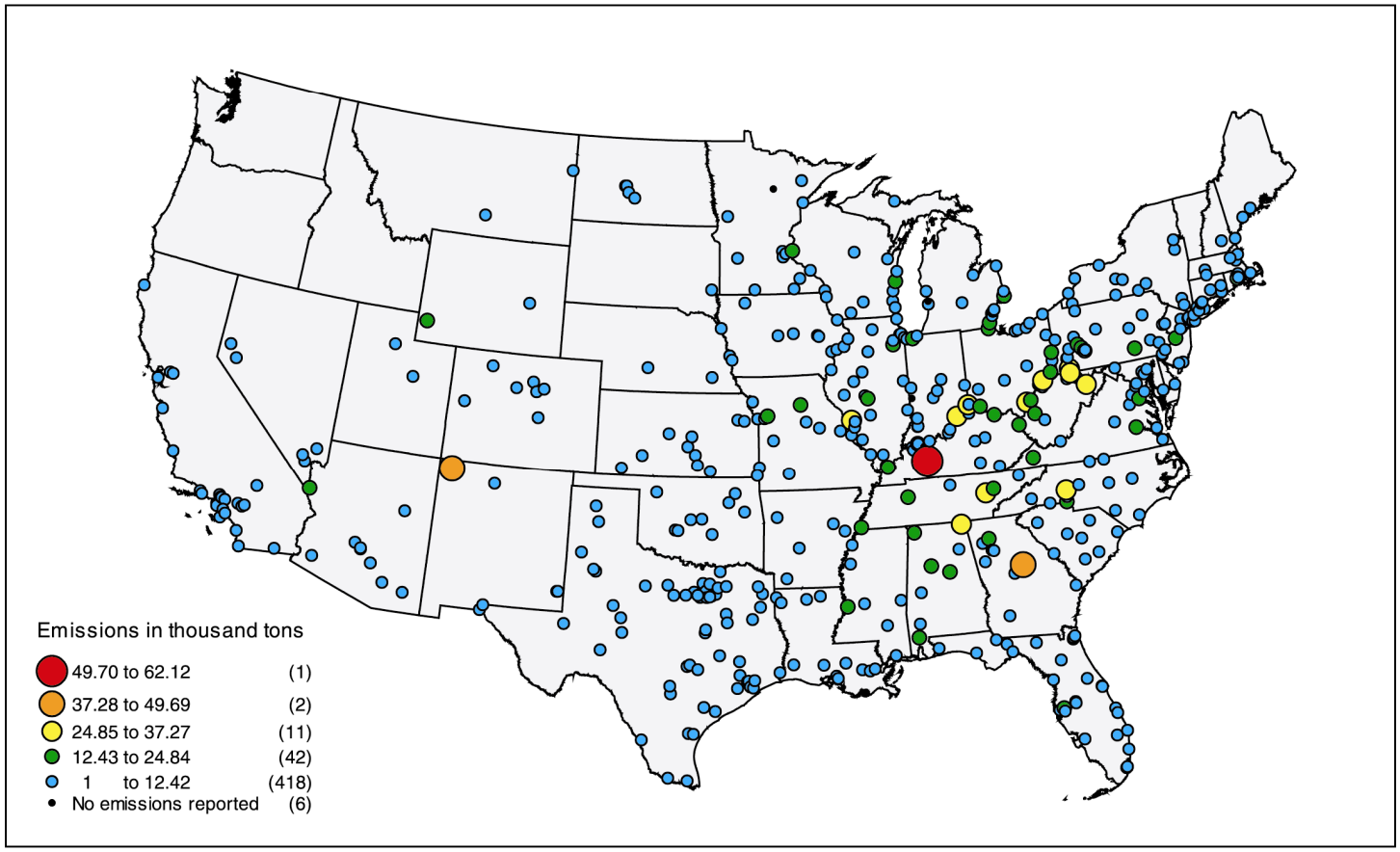
Figure 7: Additional Sulfur Dioxide Emissions from Older Units, 2000



Source: GAO analysis of Platts/RDI data.

Note: Emissions data for units at the same location were aggregated. Emissions categories were determined by taking the level of emissions at the highest-emitting unit (or co-located units) and dividing into five equal categories. Because we aggregated emissions at co-located units, the numbers in parentheses represent the number of locations, rather than the number of individual generating units, in each category.

Figure 8: Additional Nitrogen Oxides Emissions from Older Units, 2000



Source: GAO analysis of Platts/RDI data.

Note: Emissions data for units at the same location were aggregated. Emissions categories were determined by taking the level of emissions at the highest-emitting unit (or co-located units) and dividing into five equal categories. Because we aggregated emissions at co-located units, the numbers in parentheses represent the number of locations, rather than the number of individual generating units, in each category.

As noted, the additional emissions shown in figure 6 represent the emissions by older units above the limits applicable to new sources. If the same older units had generated the same quantity of electricity in 2000 but had met the new source standards, total emissions would have been lowered by an amount equal to the computed additional emissions. However, a requirement that older units meet the standards could have reduced the quantity of electricity generated, raised the price of electricity, and/or shifted generation among units. Among other things, owners might

have chosen to retire some older units rather than incur the costs of meeting the standards. According to a December 2000 Energy Information Administration study, requiring older coal units to install pollution control equipment would, by 2010, result in retirements that would reduce the nation's coal-based electricity generating capacity by 7 percent more than is otherwise projected (and the total U.S. capacity from all fuels by 3 percent), based on 1999 capacity levels. The study projected that such a requirement would cause operators of coal units to spend $73 billion dollars to install pollution control equipment by 2020. The study also concluded that electricity prices in 2010 would be 4 percent higher with a requirement to install control equipment than they would be without one.[11]

If older units had been required to meet new source standards in 2000, to the extent practicable, other units might have increased their operations—for example, by running more hours each day—to meet the demand for electricity that would have otherwise been produced by the units that retired. Because it is not possible to determine exactly which units would have been retired or run more to meet the demand, it is not possible to quantify precisely what the emissions in 2000 would have been if all units had been required to meet the new source standards. In addition, generating units that increased production to meet the demand created by retirements could have purchased sulfur dioxide emissions allowances from the retired units. Thus, the net decrease in sulfur dioxide emissions would not have been as great as the level of additional emissions reported above. Similarly, it is difficult to predict precisely how such requirements would affect future emissions levels. Any new coal, natural gas, or oil units built to replace retired units would, at a minimum, have to meet the new source standards, which would reduce the emissions for each quantity of electricity generated.

To meet the new source standards, older units would need to switch fuels, or add or upgrade pollution control equipment. Some older units already use pollution control equipment or have taken other actions to reduce their emissions of sulfur dioxide or nitrogen oxides. For example, we found that 681 older units met the sulfur dioxide standard by burning coal with low sulfur content. We also found that the use of emissions controls did not necessarily indicate that the units met the new source standards.

[11]See *Analysis of Strategies for Reducing Multiple Emissions from Power Plants: Sulfur Dioxide, Nitrogen Oxides, and Carbon Dioxide*, Office of Integrated Analysis and Forecasting, Energy Information Administration (SR/OIAF/2000-05, December 2000).

For example, 399 older units with equipment to control their nitrogen oxide emissions still exceeded the emissions standard applicable to newer units.

Agency Comments

We provided EPA with a draft of this report for review and comment. We subsequently received comments from the Office of Air Quality Planning and Standards, and the Office of Atmospheric Programs. EPA generally agreed with the information presented. Both offices suggested technical changes to the report, which we have incorporated as appropriate.

Scope and Methodology

To respond to the first objective, we reviewed information from the Energy Information Administration and EPA on air emissions, electricity generation, and the age of electricity generating units. While both agencies maintain such information, the data we needed for this analysis were not readily available in a user-friendly format. For example, EPA has reliable and timely emissions data, but the 2000 data were not available with information on electricity generation and the age of each unit.

Because of these limitations, we obtained alternative data from Platts/RDI, a private vendor that integrates EPA's emissions data with the Energy Information Administration's data on electricity generation and the age of generating units. Specifically, we obtained and analyzed air emissions and electricity generation data for each active fossil-fuel unit above 15 megawatts in generating capacity that started operating before 1972. For newer units, we obtained data on aggregate national emissions and electricity generation at units with a capacity above 15 megawatts. We chose 15 megawatts as the threshold capacity because units above that capacity accounted for almost all (about 99 percent) of the electricity generation from all fossil-fuel units in 2000. Because data on air emissions and the use of control equipment were available for only 1,157 of the 1,396 active units (83 percent), the data may not fully represent the total level of emissions and the number of units using control equipment. However, the units that did not report emissions data generated less than 1 percent of the electricity from older units and therefore are not likely to have produced large quantities of emissions.

To respond to the second objective, we identified the applicable new source standard for each type of unit, as listed in the *Code of Federal Regulations*, Title 40, part 60. We then determined the difference between the actual rate of emissions at each unit, in pounds of pollutant per unit of fuel consumed, and the rate allowed under the standard that applies to

newer units with the same capacity that burn the same fuel. We then multiplied the difference by the amount of fuel burned in 2000 to determine the annual level of "additional" emissions. In cases where EPA has not issued a standard for a particular type of unit, we excluded such units from our analysis of additional emissions. Regulations for some types of generating units were promulgated after 1971, but for purposes of this report we have not distinguished these units and have classified them as newer or older units based on their age. For example, EPA promulgated a regulation in 1978 requiring certain electric utility steam-generating units to meet new source standards. However, if one of these units was constructed after August 17, 1971, but before September 18, 1978, we classified it as a newer unit even though it would not have to meet the new source standard.

We did not attempt to estimate the costs or benefits of requiring older units to meet the new source standards. Therefore our analysis does not allow us to comment on the economic or energy security implications of requiring older units to meet the standards.

We conducted our work between October 2001 and May 2002 in accordance with generally accepted government auditing standards.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the Chairman and Ranking Minority Member of the House Committee on Energy and Commerce and its Subcommittee on Energy and Air Quality; the House Committee on Government Reform and its Subcommittee on Energy Policy, Natural Resources, and Regulatory Affairs; the Ranking Minority Member of the Senate Committee on Environment and Public Works, and its Subcommittee on Clean Air, Wetlands, and Climate Change; other interested members of Congress; the Administrator, EPA; the Secretary of Energy; the Director of the Office of Management and Budget; and other interested parties. We will also make copies available to others upon request. In addition, the report will be available at no charge on GAO's Web site at http://www.gao.gov.

If you have any questions about this report, please contact me at (202) 512-3841. Key contributors to this report are listed in appendix II.

David G. Wood

David G. Wood
Director, Natural Resources
and Environment

Appendix I: Electricity Generation and Emissions from Older Units

Table 1 presents, by state, data on older units' electricity generation; emissions of sulfur dioxide, nitrogen oxides, and carbon dioxide; and aggregate emissions of these substances.

Table 1: Electricity Generation and Emissions of Sulfur Dioxide, Nitrogen Oxides, and Carbon Dioxide from Older Units by State, 2000

State	Electricity Generation (Megawatt Hours)	Sulfur Dioxide Emissions Rate (Lbs. per Megawatt Hour)	Sulfur Dioxide Emissions (Tons)	Nitrogen Oxides Emissions Rate (Lbs. per Megawatt Hour)	Nitrogen Oxides Emissions (Tons)	Carbon Dioxide Emissions Rate (Tons per Megawatt Hour)	Carbon Dioxide Emissions (Tons)
Alabama	43,841,064	15.9	348,189	5.4	117,612	1.1	50,247,087
Arizona	6,254,947	1.6	4,965	4.5	14,026	0.8	5,154,604
Arkansas	4,344,950	1.5	3,362	2.9	6,195	0.7	3,041,883
California	49,643,659	—	0	0.7	16,196	0.6	30,594,610
Colorado	9,751,898	6.8	33,234	4.9	23,764	1.2	11,486,658
Connecticut	7,569,614	6.3	23,830	2.6	9,767	0.9	6,546,837
Delaware	2,915,799	18.9	27,601	4.0	5,795	1.2	3,597,684
District of Columbia	62,392	11.7	364	3.3	103	1.2	72,187
Florida	38,894,598	10.1	195,543	5.7	110,722	1.0	37,961,898
Georgia	26,114,968	14.4	187,523	6.2	80,521	1.0	26,968,799
Idaho	0	—	0	—	0	—	0
Illinois	49,414,341	10.8	267,923	5.1	125,767	1.1	56,372,741
Indiana	49,504,150	18.2	449,498	6.3	156,414	1.1	54,171,703
Iowa	8,373,882	10.6	44,481	5.9	24,669	1.3	10,787,523
Kansas	7,383,865	3.5	13,062	5.0	18,582	1.1	8,309,570
Kentucky	43,900,772	17.4	382,785	6.2	135,662	1.1	50,019,689
Louisiana	15,061,362	—	0	3.3	24,915	0.7	10,361,639
Maine	546,501	17.1	4,683	3.1	852	0.9	483,827
Maryland	20,043,853	18.9	189,797	5.8	57,846	1.0	20,759,129
Massachusetts	16,044,319	8.2	65,729	3.1	24,811	1.0	15,625,832
Michigan	34,882,007	11.7	203,421	3.9	68,674	1.1	38,980,846
Minnesota	10,500,702	10.3	53,832	7.2	37,903	1.2	12,603,068
Mississippi	7,285,810	4.3	15,745	6.2	22,470	1.0	7,347,536
Missouri	27,776,027	8.8	122,550	6.5	89,622	1.1	31,785,320
Montana	1,523,880	5.8	4,397	3.3	2,543	1.2	1,898,300
Nebraska	4,922,776	6.9	16,944	5.4	13,371	1.2	5,887,622
New Hampshire	3,971,049	22.7	45,027	4.0	7,969	1.2	4,639,472
Nevada	15,193,917	5.8	43,920	4.2	32,155	1.0	14,629,653
New Jersey	9,146,856	12.6	57,806	6.3	28,798	1.1	10,051,576
New Mexico	17,453,290	4.2	36,895	5.7	49,592	1.1	18,612,310
New York	35,195,389	13.0	228,813	3.3	57,300	1.0	36,715,581
North Carolina	41,162,804	12.6	258,948	4.2	87,450	1.0	41,469,611

State	Electricity Generation (Megawatt Hours)	Sulfur Dioxide Emissions Rate (Lbs. per Megawatt Hour)	Sulfur Dioxide Emissions (Tons)	Nitrogen Oxides Emissions Rate (Lbs. per Megawatt Hour)	Nitrogen Oxides Emissions (Tons)	Carbon Dioxide Emissions Rate (Tons per Megawatt Hour)	Carbon Dioxide Emissions (Tons)
North Dakota	4,300,003	20.4	43,911	5.9	12,657	1.3	5,605,774
Ohio	69,151,066	22.8	789,672	5.4	188,078	1.0	71,298,574
Oklahoma	6,743,970	—	0	3.8	12,725	0.6	4,352,123
Oregon	0	—	0	—	0	—	0
Pennsylvania	80,866,255	20.5	830,616	3.9	159,062	1.0	83,278,788
Rhode Island	0	—	0	—	0	—	0
South Carolina	15,180,903	15.9	121,059	4.7	35,399	1.0	15,772,080
South Dakota	393	—	0	—	0	0.0	4
Tennessee	41,045,623	19.3	396,165	5.1	103,751	1.1	43,178,072
Texas	68,938,998	1.2	42,411	2.7	93,228	0.7	45,508,059
Utah	2,118,089	4.2	4,462	3.4	3,555	0.9	1,978,780
Virginia	27,170,249	14.8	200,460	4.9	66,277	1.1	29,493,051
Vermont	0	—	0	—	0	—	0
Washington	0	—	0	—	0	—	0
West Virginia	46,981,339	18.6	436,309	6.4	150,433	1.0	47,548,879
Wisconsin	21,430,208	10.0	107,205	5.5	58,913	1.1	23,606,146
Wyoming	8,734,567	7.8	34,068	5.2	22,853	1.2	10,098,931
Total	**1,001,343,104**	**—**	**6,337,203**	**—**	**2,358,996**	**—**	**1,008,904,054**

Note: There was no reported electricity production or emissions from older units in Idaho, Oregon, Rhode Island, Vermont, or Washington.

Source: GAO's analysis of Platts/RDI data.

Appendix II: GAO Contacts and Staff Acknowledgments

GAO Contacts

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Acknowledgments

In addition to the individuals named above, Michael Hix, Chase Huntley, Vincent Price, and Laura Yannayon made key contributions to this report. Important contributions were also made by Cynthia Norris, Frank Rusco, and Amy Webbink.

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